CHEMICAL COORDINATION IN PLANTS

WHAT ARE PLANT HORMONES?

Movements of body parts are common in animals, but in plants, movements are seen in the form of bending, twisting and elongation of certain parts.

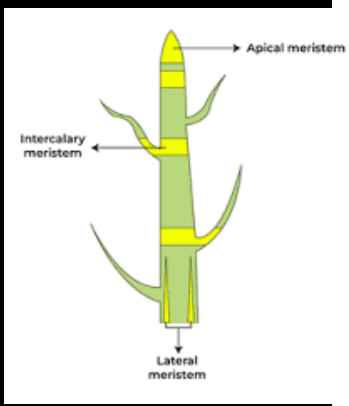
Such changes either in the external or internal environment of an organism are called stimuli and the resulting actions or movements caused by the stimuli are called responses.

Difference between Plant And Animal

1) Plants synthesize their own food, while animals depend on plants for their food directly or indirectly. Hence bodily movement in plants is not needed, while it is essential in animals.
2) Plants do not need a fast response to small changes in their immediate environment, they do not appear to have a nervous system or sense organs while animals have well developed nervous system.

Phytohormones

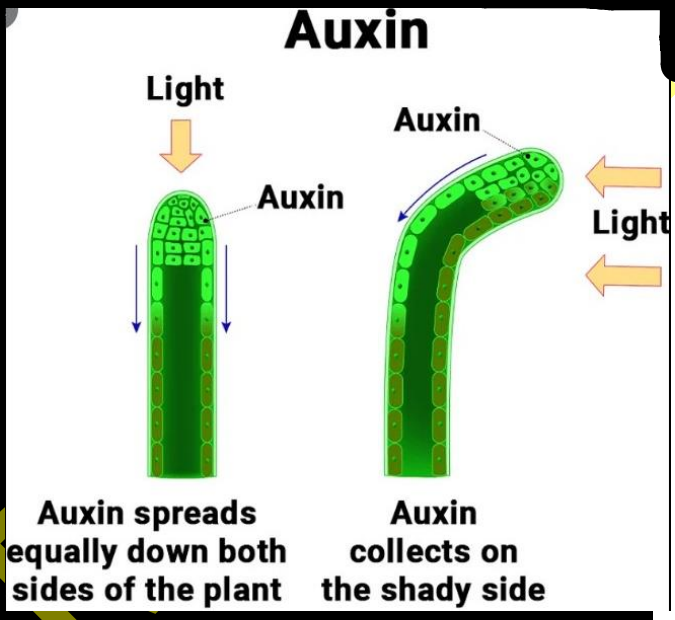
Plants respond to stimuli by producing chemical compounds called hormones that work as messengers which results in growth.



The main areas of growth (cell-division) in plants are the meristems. These areas occur just behind the tip of a shoot or root. These meristems are sensitive to hormones. The hormones help to stretch the cellulose walls of the meristematic cells to facilitate division.

The term "hormone" was first used by William Bayliss and Ernest Starling in 1902. The term phytohormone (Gk. phyton = plant) was coined to distinguish them from animal hormones.

Auxins



The term "Auxin" was first coined by F.W. Went in 1928 from the Greek word Auxin which means 'to grow. It is the first growth hormone discovered in plants. Auxins are powerful growth-stimulants and are quite effective at extremely low concentrations. Auxins are universally distributed in higher plants as well as in lower plants like algae, fungi, etc. In higher plants, they are present more in actively growing regions like shoot apex, root apex, lateral meristems, etc. IAA (Indole 3-acetic acid) is the main natural auxin found in plants.

Functions of Auxins:

1. Auxins promote the growth of stem, roots and fruits by cell elongation.
2. Auxins delay leaf senescence (ageing or falling of leaves).
3. Auxins promote the growth of apical buds and slows the growth of lateral buds.
4. Auxins induce rooting in the cutting of some plants like rose, bougainvillea etc.
5. Auxins can induce fruit formation without fertilization in fruits like apples, tomatoes, bananas, etc. Such development of fruits without fertilization is called parthenocarpy and the fruits are called parthenocarpic fruits.

Gibberellins

Gibberellins are another kind of a plant hormone. Different forms of gibberellins Ex- GA1, GA2, GA3, etc

In higher plants, gibberellins are mainly distributed in meristematic regions like stem-apex, root-apex, buds, seeds, etc.

Functions of Gibberellins :

1. The main function of gibberellins is to promote the growth of internodes by cell elongation.

2. Gibberellins break seed dormancy and initiate germination.

3. They promote fruit growth and are capable of inducing parthenocarpy.

4. They also delay sencescence (ageing).

5. Gibberellins are also widely used in horticulture and food industries. These hormones enhance longitudinal of internodes in dwarf plants. They are used commercially to increase the length of grapes, elongate apples and improve their shape.

Cytokinins

The cytokinins have been discovered comparatively recently in 1950s by Skoog and Miller. Cytokinins have specific effects on cell-division.

Cytokinins are widely distributed in plants. They are produced in root tips and are transported through xylem cells. Comparatively large amounts of cytokinins are found in germinating seeds, developing fruits, embryo, etc.

Functions of Cytokinins :

1. Cytokinins stimulate plant growth by cell division.

3. They break seed dormancy and promote germination.

4. They promote chlorophyll synthesis in chloroplasts and delay leaf senescence.

5. Cytokinins stops apical dominance.

Ethylene

Ethylene is the only hormone which is a gas at ordinary temperature. It is produced in fruits and remain in the same fruit. Therefore unlike other hormones, its site of synthesis and site of action are not different. Ethylene Founder by R. Gane.

Ethylene is produced in higher plants, and fungi. All living cells are capable of producing ethylene, but more ethylene is produced in meristematic tissues.

Functions of Ethylene :

Ethylene causes two processes in plants reduction in stem elongation and acceleration of senescence. Besides, it also helps in:

1. Ripening of fruits.

2. Initiating germination in peanut seeds.

3. Sprouting of potato tuber.

4. Promoting root growth and root-hair formation.

5. Inducing flowering in mango.

Thus, ethylene is the most widely used plant growth hormone in agriculture.

Abscisic acid (ABA)

Abscisic acid is a growth-retarding hormone. It is found in angiosperms, gymnosperms, pteridophytes and some mosses. It is

found in the chloroplasts of leaves. Fruits and seeds contain the highest amount of ABA.

Functions of ABA :

1. Abscisic acid acts as a general plant growth inhibitor by slowing down plant metabolism.

2. ABA inhibits seed germination and development.

3. It accelerates senescence (ageing) and abscission (falling) of leaves, buds, flowers and fruits.

4. ABA stimulates the closure of stomata in the epidermis and increases the tolerance of plants to various kinds of stresses. Therefore, it is also called the "stress hormone".

TROPIC MOVEMENTS IN PLANTS

The movements of the plant part in direct response to external stimuli. The direction of the response is related to the direction from which the stimulus comes. Such a response is known as tropism.

The term "tropic" comes from a Greek word "tropos" which means to "turn". Growth movements occurring in response to unidirectional external stimuli in a plant part are called tropic movements. Some of the tropic movements in plants are as follows:

Phototropism

Phototropism means movement towards light.

Shoots grow towards light so they are called positively phototropic and roots move away from light so they are negatively phototropic.

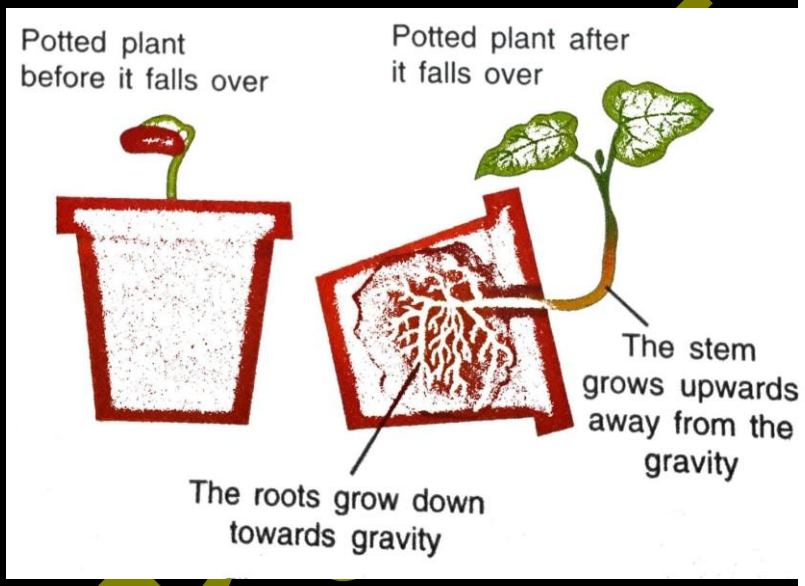
Auxins play an important role in phototropism. Auxins help in the bending of a shoot towards the source of light by getting

This results in rapid cell-elongation (growth) in this side, thus causing the shoot to bend towards the source of light.

Geotropism

The term **geotropism** means growing towards the **earth's gravity**. It is also called gravitropism.

Organs which grow towards the gravity are **positively geotropic** (e.g. root tip) and those that grow away from the gravity are **negatively geotropic** (e.g. shoot tip).



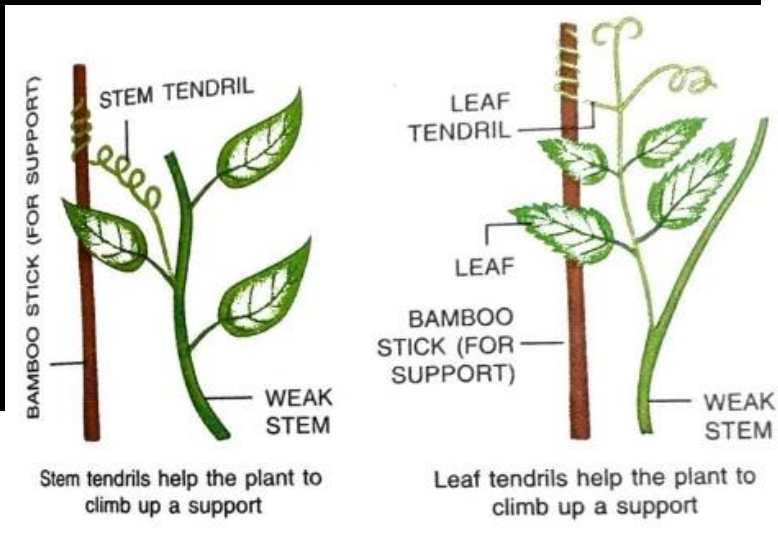
Hydrotropism

The movement of plant parts in response to **water or moisture** is called **hydrotropism**. When a plant part grows towards the source of moisture (for e.g. roots), it is said to be **positively hydrotropic**. The growth of roots towards moisture ensures that roots will be near the water available in the soil. When a plant part grows away from the source of moisture, it is said to be **negatively hydrotropic** (for e.g. shoot).

Thigmotropism

The growth movement of plant parts in response to **touch stimulus** is called **thigmotropism.**

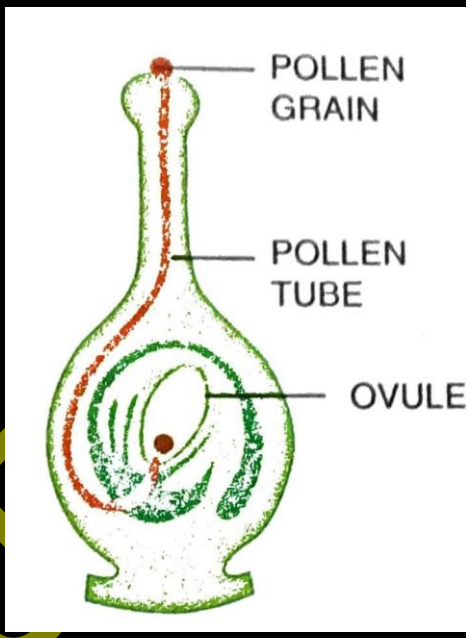
Plants such as sweet peas, Cuscuta and vines have tendrils



response to one sided contact or touch. In pea plants tendrils provide a well-known example of thigmotropism.

Chemotropism

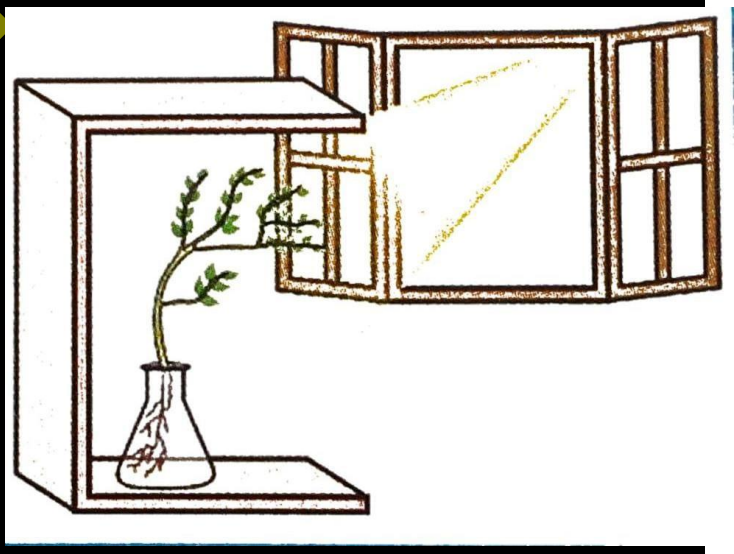
Chemotropism is the phenomenon of growth of plant organs in response to chemicals. The movement of pollen-tube of angiosperms and gymnosperms towards sugars and peptones secreted by neck canal cells of the female gametophyte is an example of chemotropism. The movement of fungi growing towards the areas richer in food is also chemotropism.



ACTIVITIES

Activity 1: To show Phototropism

Take a healthy potted plant. Keep this plant inside a dark room by the side of an open window. After a few days, you will notice that the plant bends towards the open window. The plant is showing a positive response to light. This is called positive phototropism.



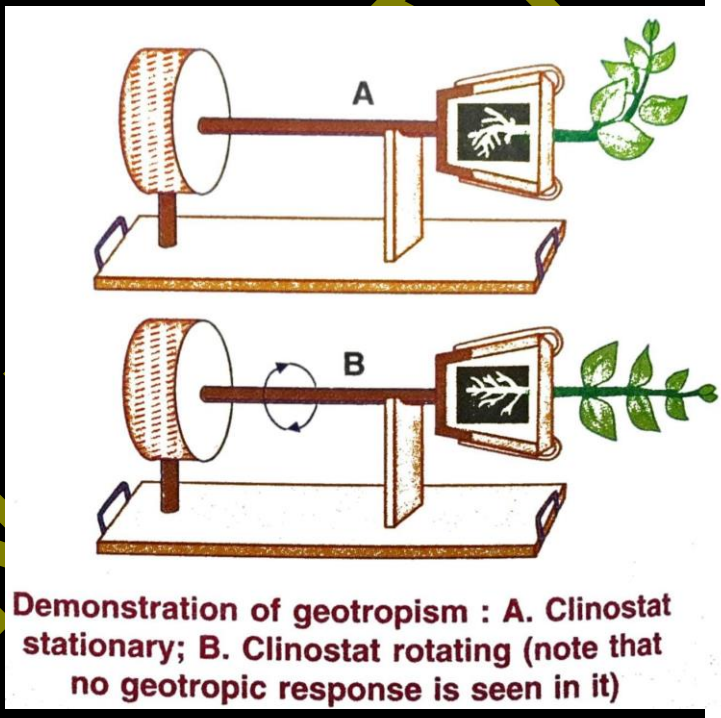
Activity 2: The Show Geotropism

Take a few seeds of bean or gram, and sow them in moist

four days, the seeds will sprout. Each seed will give rise to a tiny seedling. Water the seedlings regularly. Observe their growth for 8-9 days. Notice the increase in the length of the stem growing away from the force of gravity, and that of the roots growing towards the force of gravity. The growth in the stem shows negative (away) response to gravity, while the root shows positive (towards) response to gravity.

Activity 3: To show Geotropism

Geotropism can be demonstrated in the laboratory with the help of an instrument called Clinostat. It can allow a potted plant to rotate at a slow speed. Two such instruments are taken which are fixed with potted plants horizontally. One is rotated and the other is not. After sometime, you will see that the shoot of stationary clinostat shows negative geotropism and roots show positive geotropism. The other potted plant does not show any bending. This is due to the fact that all parts are equally exposed to the gravitational force during rotation.

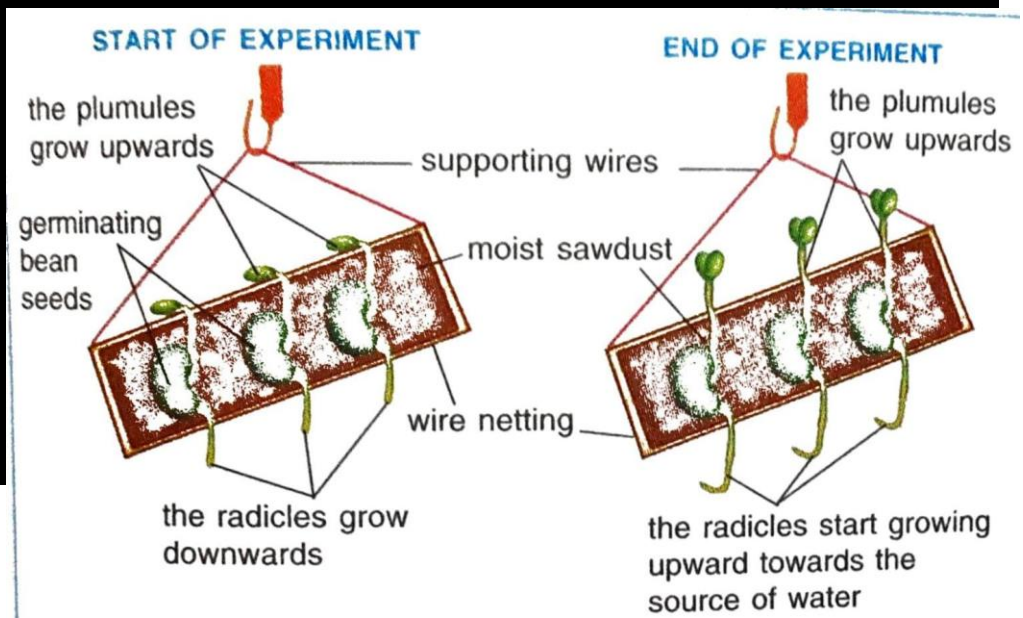


Demonstration of geotropism : A. Clinostat stationary; B. Clinostat rotating (note that no geotropic response is seen in it)

Activity 4: To show Hydrotropism

To investigate the effects of water on the growth of roots and shoots.

Take a piece of wire netting or gauze. Suspend it by means of wires. Moist



inch) is placed on the wire netting and some germinating bean seeds are embedded in the sawdust.

As the seeds germinate, the radicles initially grow downwards through the wire netting under the influence of gravity. But soon, they start growing upwards, towards the moist sawdust, which is the only source of water. In doing so, they grow against the force of gravity. The shoots grow upwards all the time.

This experiment shows that the roots grow towards water and shoots do not. For the roots, water is a more effective stimulus than gravity.